The Sizewell C Project

9.13 Sizewell C Coastal Defences Design Report

Revision: 1.0

Applicable Regulation: Regulation 5(2)(q)

PINS Reference Number: EN010012

June 2021

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

SizewellC
Doing the power of good for Britain
EDF CGN

CONTENTS

TABLES

FIGURES

APPENDICES

GLOSSARY

ALARP	As Low As Reasonably Practicable
AOD	Above Ordnance Datum
BECC	British Energy Climate Change
BLF	Beach Landing Facility
BOD	Basis of Design
CD	Chart Datum
CM	Credible Maximum
CMC	Controlled Modulus Column
CoW	Cut-off Wall
CPMMP	Coastal Processes Monitoring and Mitigation Plan
DCO	Development Consent Order
EA	Environment Agency
EMIT	Examination, Maintenance, Inspection and Testing
ExA	Examining Authority
FRA	Flood Risk Assessment
HCDF	Hard Coastal Defence Feature
HPC	Hinkley Point C
IAEA	International Atomic Energy Agency
MBIF	Marine Bulk Import Facility
MCA	Main Construction Area
MHWS	Mean High Water Springs)
MSF	Main Safety Function
OD	Ordnance Datum (Newlyn)
ONR	Office for Nuclear Regulation
PLSF	Plant Level Safety Function
PRoW	Public Right of Way
RCP	Representative Concentration Pathway
RF	Reasonably Foreseeable
SCDF	Soft Coastal Defence Feature
SLR	Sea Level Rise
SSSI	Site of Special Scientific Interest
SZB	Sizewell B Nuclear Licensed Site
SZC	Proposed Sizewell C Nuclear Licensed Site
UKCP	United Kingdom Climate Projections

1 INTRODUCTION

1.1.1 In January 2021, SZC Co made an application to the Planning Inspectorate to amend the DCO submission that was made in May 2020 to build and operate a nuclear power station on the coast at Sizewell (the Sizewell C Project). One of the changes requested related to the design of the sea defences (hard coastal defence feature; HCDF) where the crest would be higher and extend further seaward (to the east). A second change in relation to the sea defences was the replacement of a rock armour temporary sea-defence during construction with a sheet-piled temporary defence.

1.1.2 During post-submission consultation carried out by SZC Co with East Suffolk Council (ESC), together with the Environment Agency (EA), Marine Management Organisation (MMO) and Natural England (NE), requests have been made for further design detail to be provided, including scaled plans and sections, and evidence that the seaward extent of the HCDF has been limited as much as possible. A number of other stakeholders had also raised lack of design detail as an issue in their Section 56 relevant representations for the original May 2020 DCO submission.

1.1.3 In light of the response by stakeholders, in the preliminary hearings, the ExA requested 'Design details and plans for Hard Coastal Defence Feature (HCDF)', to be provided to the examination at Deadline 2 on 2nd June. This 'Sizewell C Coastal Defences Design Report' has been prepared in response to this information request and is not for approval. In addition, reference is made in the report to the ExA's first round of Written Questions, specifically in respect of questions BIO.1.30, FR.1.0 and FR.1.3 as set out in Table 1-1 below.

Table 1-1 - ExA questions and coverage in this document

Question ref	Question text	Primary location of response / justification
Bio 1.30	Many IPs have raised concern over the absence of design of the HCDF. Please will the Applicant either; (a) table the design …	Sections 2.2, 3.4
	… or (b) explain why it is acceptable to proceed on the basis of the descriptions provided in the Application, pointing exactly to the material on which the Applicant relies. If the Applicant chooses (b), please will it also supply plans, sections and elevations on an OS base of what could be constructed.	n/a – response route (a) adopted

Question ref	Question text	Primary location of response / justification
FR 1.0	Main Platform – Temporary Coastal Defences Paragraph 7.1.12 of [AS-018] states a temporary reinforced coastal flood defence will be built to form the haul road. Paragraph 4.2.6 of [AS-157] confirms that a temporary sheet pile wall of 7.3m AOD is now also proposed. There is little detail on the process of constructing these temporary works, including removing existing sea defences, placing temporary defences and constructing the permanent defences. Additionally, there is little detail on the timing of the various elements of sea defence works. Figures 2.2.20 to 2.2.23 [AS-190] provide some detail. Provide more detail on the sea defence construction programme and plans showing how they will develop in relation to construction	Temporary Sea Defence – Sections 3.2, 4.1. Permanent Sea Defence – Sections 3.3, 4.2
FR 1.3	Main Platform – Adaptive Sea Defence The Environment Agency [RR-0373] and other IP's ask for more detail on the design and construction of the Hard Coastal Defence Feature (HCDF). Paragraphs 4.2.13 to 4.2.17 and Plates 4.3 and 4.4 of [AS-157] provide some information on the HCDF. However, the detailed design and construction of the HCDF has still not been set out. Provide a detailed description of the design and construction of the HCDF including how any subsequent adaptive element will be provided.	HCDF design details – Section 3.4 HCDF construction methodology – Section 4.2 Adaptive Element Design – Section 3.8 Adaptive Element construction – Section 4.3

1.1.4 All levels given in this Technical note are designed finished levels including for the future effects of settlement.

1.1.5 Typical cross-sections provided in this document (Figure 3-2, Figure 3-3, etc.) are taken at an approximate Northing of 264015m. This is located slightly to the south of the combined outfall tunnel, and is representative of the typical run of the Sea Defences. The beach profiles presented in cross sections are taken from Channel Coastal Observatory data at February 2020[1]. Larger-scale sections are presented at Appendix A (A.1, A.2, etc.).

[1] https://coastalmonitoring.org/

2 DCO APPLICATION AND CHANGE SUBMISSION

2.1 May 2020 DCO Application

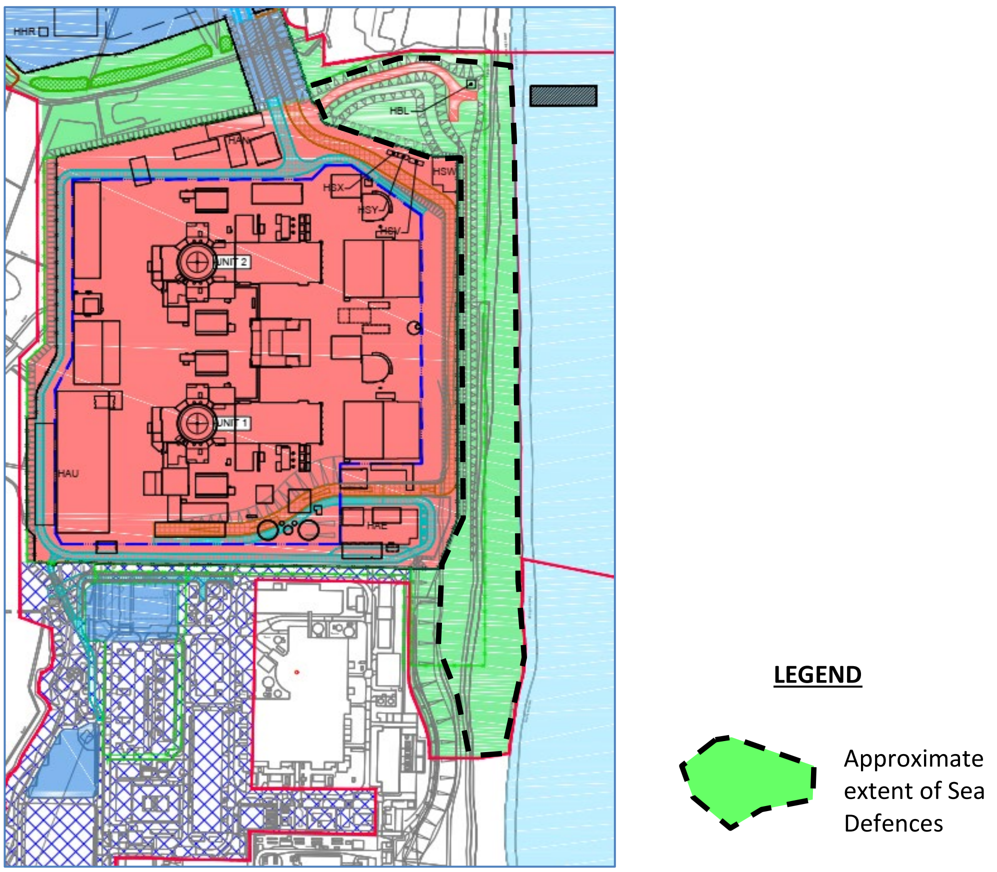
2.1.1 The principal design parameters supporting the DCO application were:

- The design life of the structure was 80 years (up to 2110).
- Climate change parameters based on using UKCP09.
- Structure to be earthquake-resistant (seismic design).

2.1.2 Other design parameters including the design basis storm event are defined by ONR and EA guidance and have remained unchanged.

2.1.3 Figure 2-1 shows the sea defence layout from the May 2020 DCO submission:

Figure 2-1 - Sea Defence Layout, May 2020 DCO submission



2.1.4 The sea defence comprised the following elements:

- A Temporary Sea Defence comprising a rock revetment to a level of +7.0m OD with an earth bund on top providing screening up to +10.0m OD.
- A Soft Coast Defence feature (SCDF) shown on the drawings as infill on the existing beach crest.
- A Permanent Sea Defence, comprising a rock-armoured revetment sea defence with crest level (excluding landscaping) +10.2m OD.
- An adaptive sea defence with crest level (excluding landscaping) of +14.2m OD.

2.1.5 Figure 3-2 and Figure 2-3 show the typical cross-sections of the Temporary and Permanent Sea Defences current at that time. A larger scale cross-section of the Permanent Sea Defence is provided at Appendix A.1.

Figure 2-2 - Temporary Sea Defence, Typical Cross-section Underpinning May 2020 DCO Submission

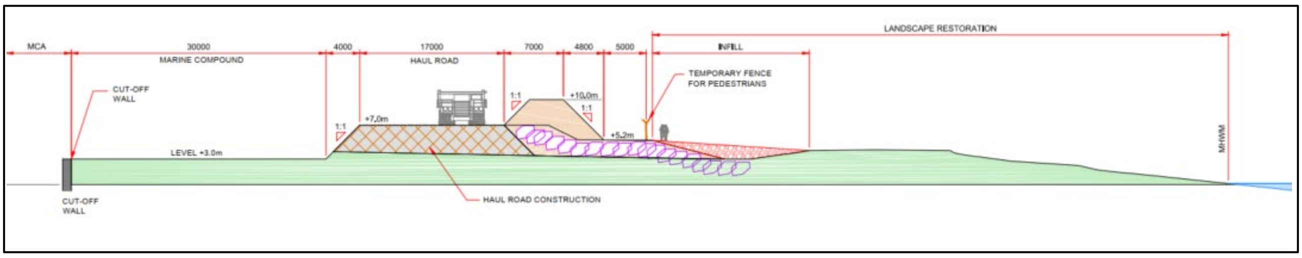
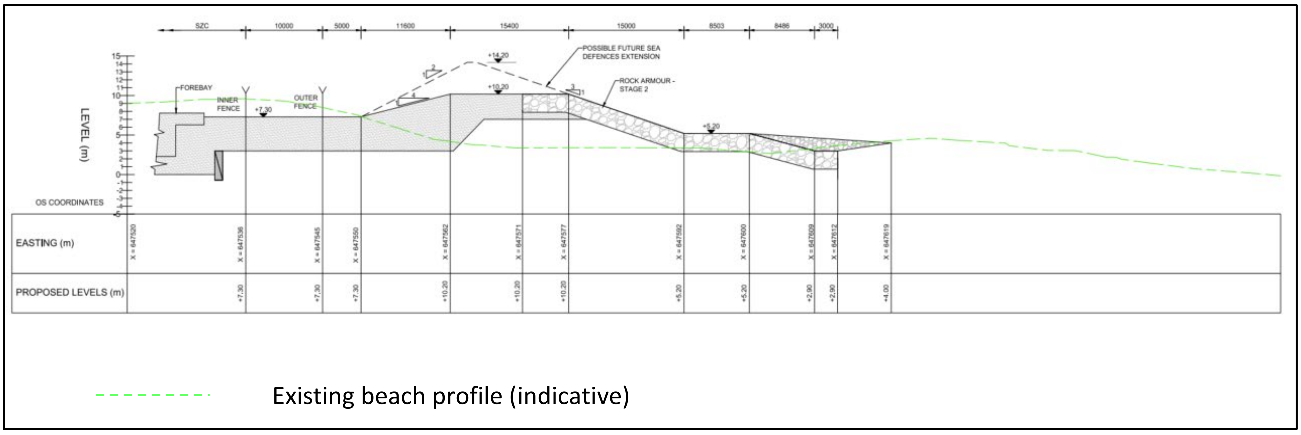


Figure 2-3 - Permanent Sea Defence, Typical Cross-section Underpinning May 2020 DCO Submission



2.2 January 2021 Change Submission

2.2.1 The principal design parameters are now:

- The design life of the structure is 110 years (up to 2140 – extended to accommodate change in spent fuel storage strategy)
- Climate change parameters based on using UKCP18.
- Structure to be earthquake-resistant (seismic design).

2.2.2 The above changes have increased the extreme 1 in 10,000yr design Still Water Level from 5.95m OD to 7.02m OD. The design Still Water Level is defined as the estimated present-day extreme water level including surge, derived from a statistical analysis, plus the climate change increase in mean sea level and surge to the year 2140.

2.2.3 The modified sea defence design comprises the following elements:

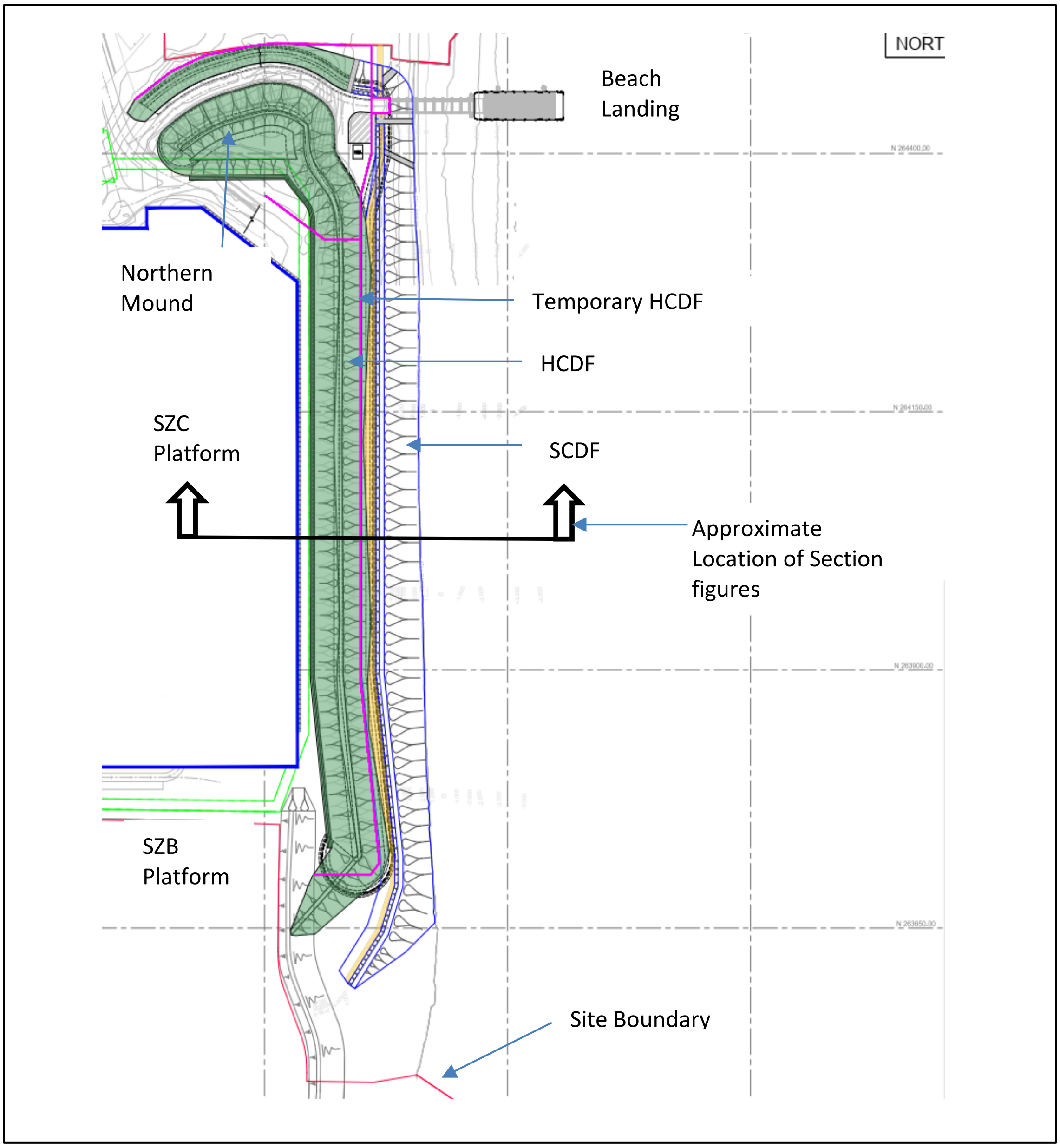
- A temporary sea defence during construction comprising a steel sheetpile wall to a level of +7.3m OD.
- A permanent hard coastal defence feature (HCDF) comprising a rock armour revetment to a level +12.6m OD.
- Up to 2m thickness of landscaping over the revetment on the seaward slope giving a maximum total height of +14.6m OD.
- An adaptive sea defence height of +16.4m OD excluding landscaping, with a maximum height of +18.0m OD including landscaping.
- A soft coastal defence feature (SCDF) of pebbles and cobbles to a level of +6.4m OD.

3 DESIGN DESCRIPTION

3.1 General

3.1.1 The plan of the proposed Sea Defences (accepted change) is shown in Figure 3-1. The pink line shows the proposed temporary sheetpile sea defence. This would be present during construction and would then be replaced by the permanent sea defences that would be in place throughout the operational life of the power station and during decommissioning until 2140. The black lines show the proposed permanent HCDF. The green shading denotes landscaping and yellow shading the coast path. The slope indicators bounded by blue line are the proposed SCDF.

Figure 3-1 - Sea Defence Layout

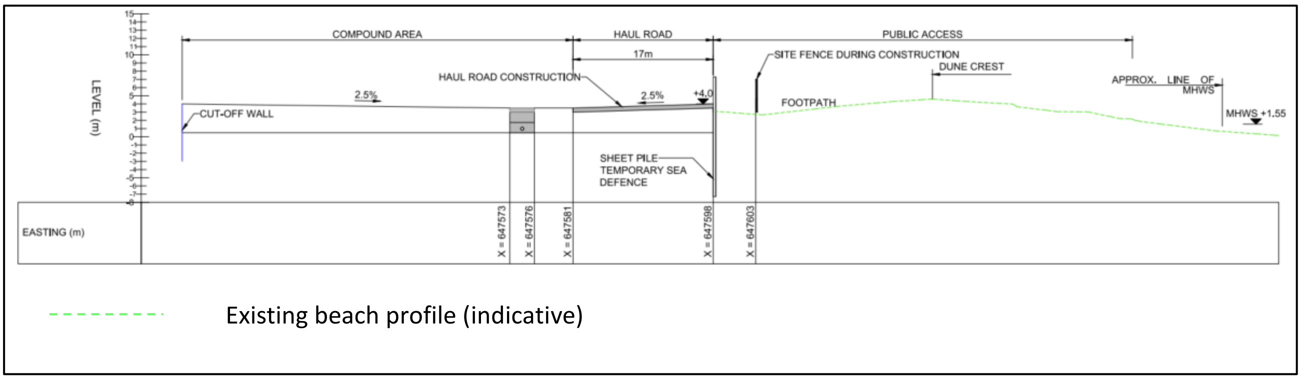


3.2 Temporary Hard Coast Defence Feature

3.2.1 A temporary sea defence is proposed to protect the existing SZB nuclear power station and the proposed Sizewell C Main Construction Area (MCA) from coastal flooding during the construction phase. This would take the form of a sheetpiled wall, with crest height +7.3mOD, overlapping the existing SZB sea defences at the south, running northwards to form the perimeter of the SZC MCA, and tying-in at the Northern Mound. The alignment is represented by the pink line in Figure 3-1.

3.2.2 This updated design was introduced in the January 2021 change submission to increase working space within the SZC MCA. The typical cross-section of this temporary sea defence along the eastern flank of the MCA is shown on Figure 3-2 and in larger scale at Appendix A.2.

Figure 3-2 - Temporary HCDF, Typical Cross-Section



3.2.3 The temporary HCDF would be installed as one of the earliest construction activities, prior to the removal of the existing ridge (“Bent Hills”) which provides a part of the existing SZB Sea Defences.

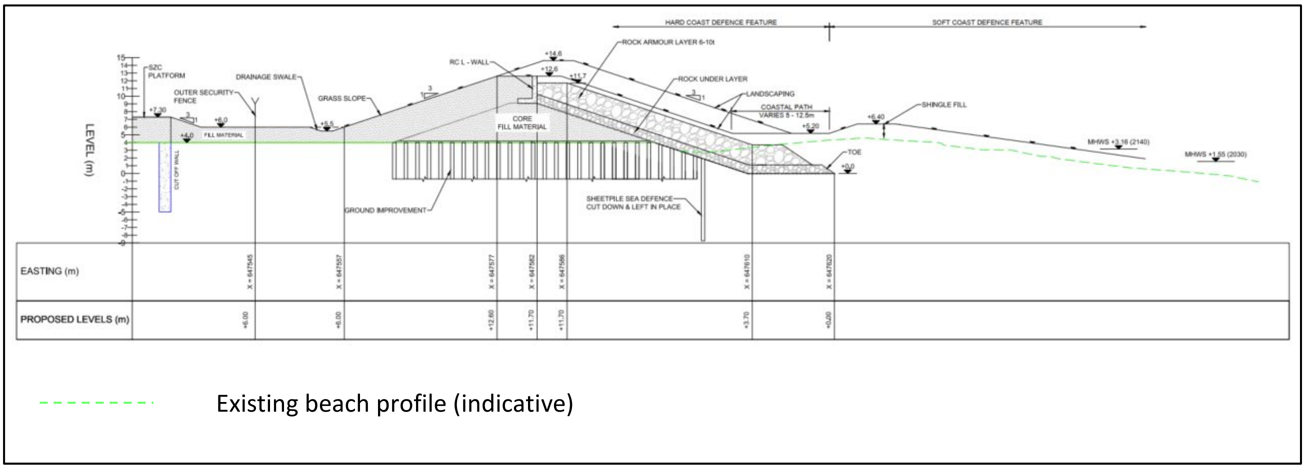
3.2.4 The temporary HCDF alignment encompasses the Northern Mound to provide protection to the MCA excavation during reconstruction of the Northern Mound. It may be possible to reduce the northern extent of the sheetpiling in detailed design stages.

3.3 Permanent Sea Defence

3.3.1 The Permanent Sea Defence comprises two distinct, but functionally and spatially interconnected, elements; the Hard Coastal Defence Feature (HCDF) and the Soft Coastal Defence Feature (SCDF). There is also provision for an Adaptive Design of the Permanent Sea Defence to be implemented. The Adaptive Design will only be implemented if mean sea level rise exceeds the reasonably foreseeable design value during the operational life of the structures from approximately 2030 to 2140 (see Section a) *et seq*. for further details of trigger criteria for the implementation of the Adaptive Design).

3.3.2 A typical cross section of the Permanent Sea Defence is presented at Figure 3-3. A larger scale section is provided at Appendix A.3. The water levels shown are at the end of design life (2140), including for sea level rise according to RCP8.5, 95%-ile. MHWS in 2030 (start of operations) is also shown for comparison. The green line is the February 2020 measured beach profile as noted in Section 1.1.5.

Figure 3-3 – Permanent Sea Defence, Typical Cross-section



3.3.3 The seaward toe of the sea defence in the January 2021 Change submission extends approximately 8m further east (seaward) than in the original DCO submission. This change in seaward extent is driven by the change in crest level of the Permanent Sea Defence (+10.2mOD in May 2020 submission, increasing to +12.6mOD in the change submission) and the minimum 5m standoff to the outer SZC site fence that fixes the landward (western) boundary. This security standoff represents a minimum value that was already assumed in the May 2020 DCO application in order to minimise the SZC footprint. The increase in crest height is due to the increase in climate change allowance between UKCP09 and UKCP18 and the extended design life of the sea defence.

3.3.4 The design considers a number of constraints and interfaces, including:

- The Beach Landing Facilities (Permanent and Temporary BLFs)
- The cut-off wall design and construction (anchors)
- Tunnel routes under the sea defence
- Permanent security fence
- Public Right of Way (PRoW)
- Northern transition (Northern Mound)
- Southern transition (SZB sea defences)
- Drainage design of platform
- Landscaping treatment and profiles

- Minimising seaward extent of HCDF commensurate with engineering function.

a) Basis of Design

3.3.5 Table 3-1 summarises the design basis storm event conditions for both Reasonably Foreseeable (RF) and Credible Maximum (CM) scenarios.

3.3.6 The RF climate change scenario is the design basis for the Permanent Sea Defence. RF is a conservative estimate of future climate change as it uses the highest climate change scenario (RCP 8.5 95%tile).

3.3.7 The Credible Maximum (CM) has been taken as the H++ scenario defined in UKCP09 (not updated for UKCP18). It provides an estimate of sea level rise beyond the likely range but within physical plausibility. The CM case is the design case for the Adaptive Design which is described in more detail at Section 3.8.

3.3.8 Both scenarios must cater for the 1 in 10 000 year design basis storm event, and be tested against the 1 in 100 000 year beyond-design-basis event to identify any "cliff edge" effects that would also need to be designed for.

Table 3-1 - Design Parameters

Climate Change/ Timescale	Design Cases (Design Basis)	Design Case: Cliff Edge (Beyond Design Basis)
Reasonably Foreseeable (RF) 2110-2140	1 in 10,000 year return period storm event (95%ile) UKCP18, RCP8.5 – 95%ile SLR Long-term coastal erosion of 0 – 20m Hydraulic roughness 0.5 Storminess Wave Height Increase 10% Existing protection from offshore banks	1 in 100,000 year return period storm event (50%ile) UKCP18, RCP8.5 – 95%ile SLR Long-term coastal erosion of 0 – 20m Hydraulic roughness 0.5 Storminess Wave Height Increase 10% Existing protection from offshore banks
Credible Maximum (CM) 2110 -2140	1 in 10,000 year return period storm event (95%ile) H++ sea level rise – BECC Upper Long-term coastal erosion of 20m to 40m Hydraulic roughness 0.5 Storminess Wave Height Increase 10%	1 in 100,000 year return period storm event (50%ile) H++ sea level rise – BECC Upper Long-term coastal erosion of 20m to 40m Hydraulic roughness 0.5 Storminess Wave Height Increase 10% Offshore banks lowered in height

Climate Change/ Timescale	Design Cases (Design Basis)	Design Case: Cliff Edge (Beyond Design Basis)
	Offshore banks lowered in height	

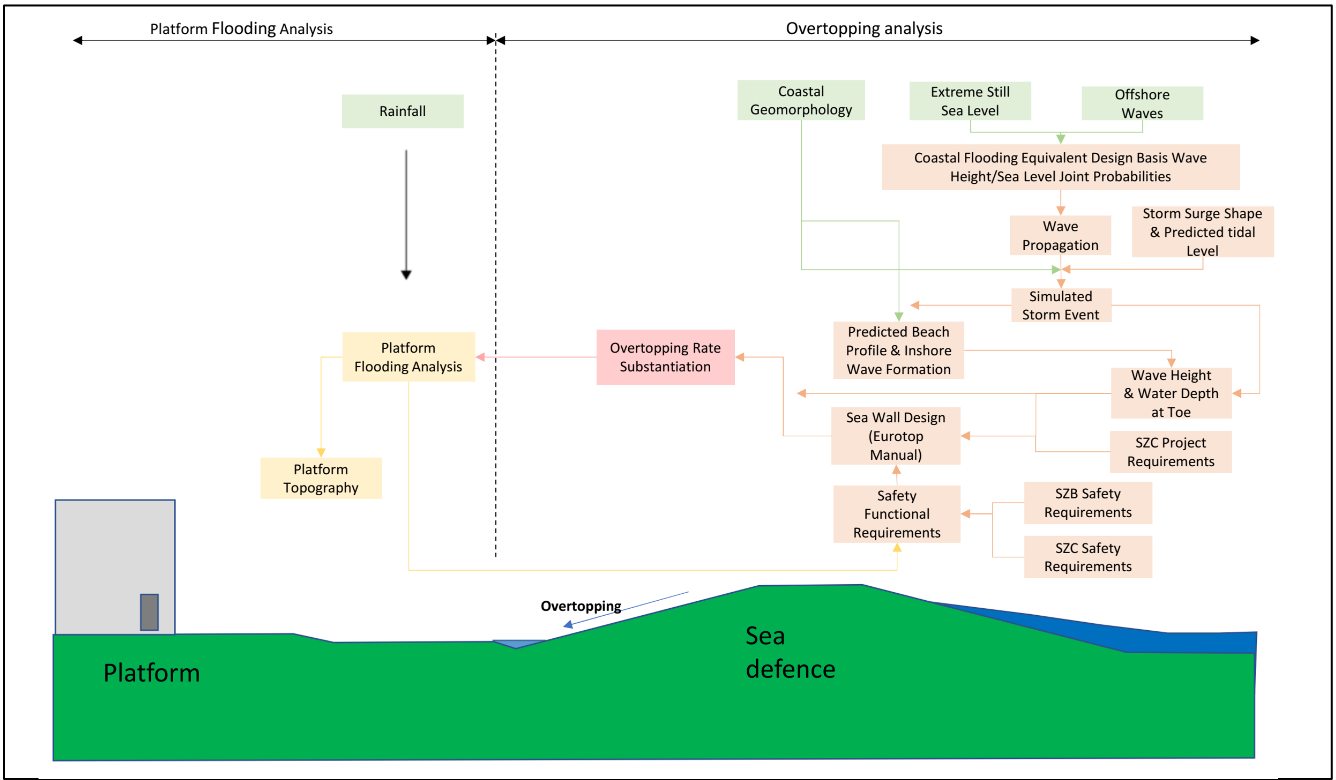
b) Design Methodology

3.3.9 The key inshore design parameters for the sea defence are:

- Wave height and still water level pairs at the toe at the toe of the HCDF.
- Associated wave direction and period.

3.3.10 These parameters are derived from a combination of numerical wave and beach modelling to take account of the environmental considerations including coastal geomorphological processes responsible for coastal change. Figure 3-4 shows the process used to obtain these inshore design parameters. The inshore parameters were then used to calculate the overtopping of the sea defence and the stability of the rock armour slope.

Figure 3-4 - Design Methodology



3.4 Hard Coastal Defence Feature (HCDF)

3.4.1 The HCDF comprises a rock revetment with a double armour layer of 6 to 10 tonne quarried armour stone rock over a rock underlayer, granular core and ground improvements (where needed).

3.4.2 The primary physical elements of the HCDF design cross section include: crest height, slope angle, rock size, toe level, core fill material specification, and foundation design. Table 3-2 lists the physical design parameters that affect the form and level.

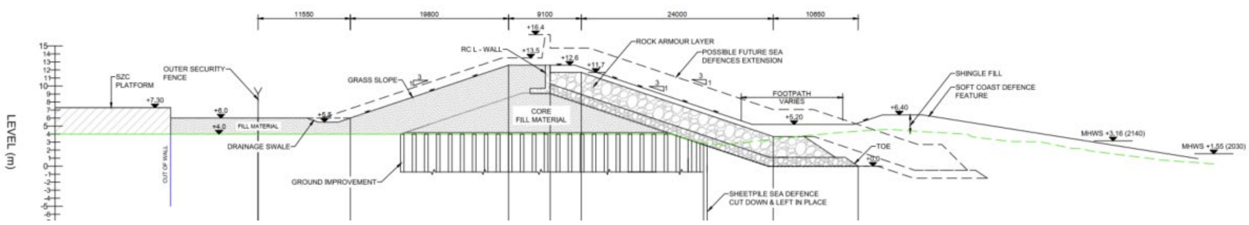
Table 3-2 - Physical Design Parameters

Physical Parameter	Design parameters	Comments
Armour Size	– Wave height and period – Storm duration – Structure porosity – Structure Slope angle	It is desirable to use standard grading 6-10t rock as this is largest readily available size. A concrete armour solution is frequently considered when a larger rock size is required. A concrete armour solution is not required for the HCDF but may be required for the Adaptive Design.
Crest Height	Overtopping volume which is dependent on: – Slope roughness – Wave height and water level combination – Structure slope angle	Crest height is set to achieve a peak allowable overtopping rate. This is specified at 2 l/s/m for the design basis event. This limit was found to be acceptable in the context of flood risk to the station platform and also stability of the HCDF backslope.
Slope angle	– Internal angle of friction of the core fill material and other layers, which affects the slope stability. – Seismic loading (slope stability)	Slope angle affects other parameters such as scour depth rock stability and overtopping. Steep slopes cause greater wave reflection which causes scour. A 1 in 3 slope has low reflection characteristics.
Toe Level/Scour	– Design Basis Simulated Storm Event – Beach profile/SCDF response to the storm event	The level of the toe is set at below the predicted scour level for the design basis storm event.
Core	– Interface stability under hydraulic loading – Internal stability under seepage pressure	Core material needs to be an engineered fill to be suitable for use.

Physical Parameter	Design parameters	Comments
	– Compressibility and strength requirements	
Foundation	– Underlying soil strata physical properties – Slope stability including under seismic loading	Sea defence needs ground treatment in most locations because of underlying low strength layers of peat

3.4.3 Figure 3-5 shows both the Permanent Sea Defence design with the outline of the Adaptive Design superimposed on it. The HCDF toe is set beneath the SCDF level in both scenarios.

Figure 3-5 - Permanent Sea Defence, Cross-Sections (Baseline and Adaptive)



Existing beach profile (indicative)

3.4.4 Numerical modelling of the beach storm response indicates that the toe of the HCDF would not be at risk of being exposed in a design basis 1 in 10 000 year storm event provided it is set at 0.0m OD or lower. This modelling is based on the 2140 climate change parameters (RCP8.5, 95%ile). These profiles will be subject to further study and modelling work during the detailed design.

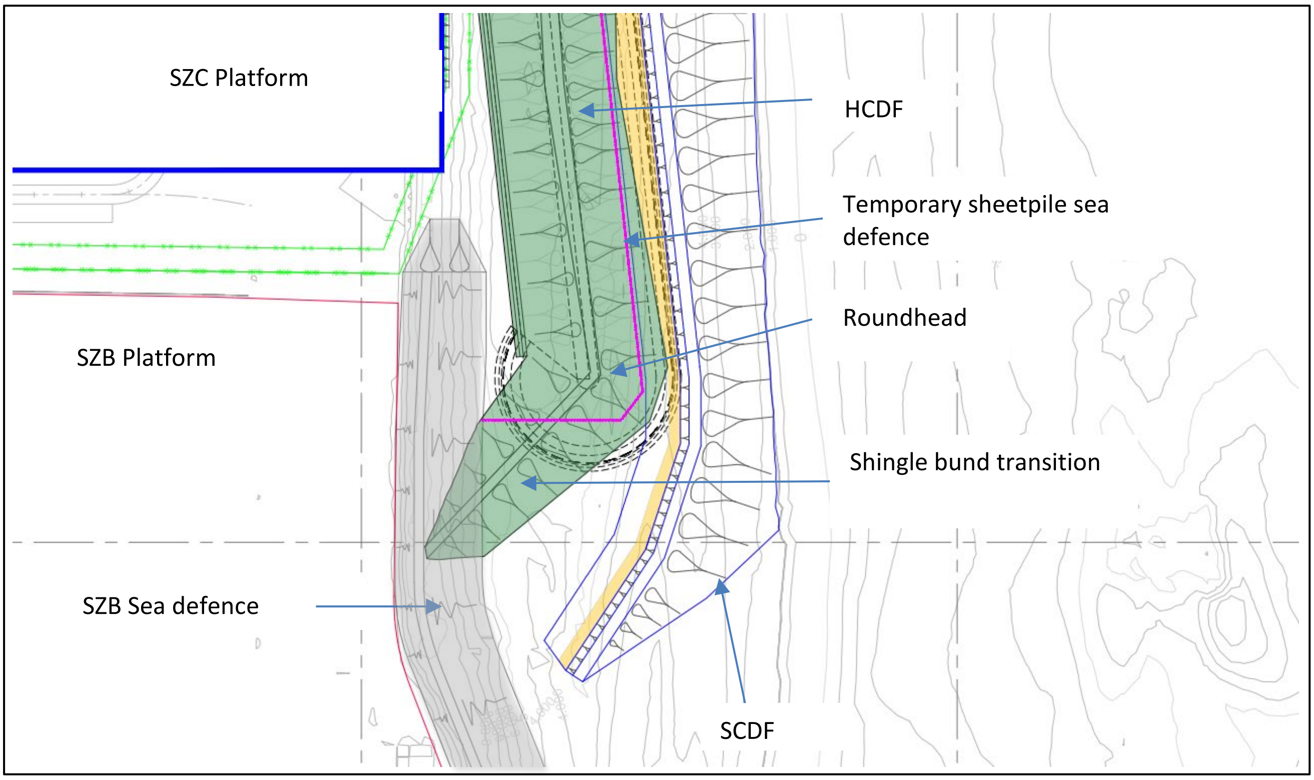
Table 3-3 - Minimum toe level results from model output

1 in 10,000yr Storm With reasonably foreseeable climate change	1 in 100,000yr Storm With reasonably foreseeable climate change
+0.50 mOD	+0.46 mOD

a) SZB Tie In

3.4.5 The design of the interface with the SZB defences has been refined since the design phase underpinning the May 2020 DCO submission. The SZC Permanent Sea Defences are to be seismically qualified, whereas it has been confirmed that the existing SZB sea defences are not seismically qualified. It is therefore necessary to separate the two defence structures from one another. The proposed SZC sea defence included in the January 2021 change submission overlaps the SZB defence rather than merging into it.

Figure 3-6 - SZB Interface - Plan



3.5 Landscape

3.5.1 For amenity and screening purposes, the HCDF would be landscaped. The landscaped height undulates between +13.2m OD and +14.6 m OD to give it a natural appearance as is the case with the existing SZB sea defences.

3.5.2 Landscaping material placed above the functional crest level of +12.6mOD is not considered to contribute to the claimed performance of the HCDF. However, it is recognised that the presence of this material will in practice provide some beneficial effect.

3.5.3 This revised design maintains the Coast Path along the seaward face of the Permanent Sea Defence, at a level of approximately +5.2mOD.

3.6 Drainage Swale

3.6.1 A swale has been indicated in the space between the landward slope of the HCDF and the SZC platform, as shown in Figure 3-3 and Appendix A.3. The swale is included as a beneficial feature, but is not strictly necessary in order to meet drainage requirements. The swale will increase the volume available between the HCDF and the SZC platform for storage, infiltration and guidance of runoff surface and any overtopping water from the HCDF. The inclusion of this swale has no impact on the seaward extent of the HCDF, which is driven by the Adaptive Design configuration.

3.6.2 The swale would not be present in the Adaptive Design configuration. The landward slope of the Adaptive Design is set at the 5m minimum offset from the outer fence line and it is this which defines the seaward extent of the HCDF.

3.7 Soft Coastal Defence Feature (SCDF)

a) Description

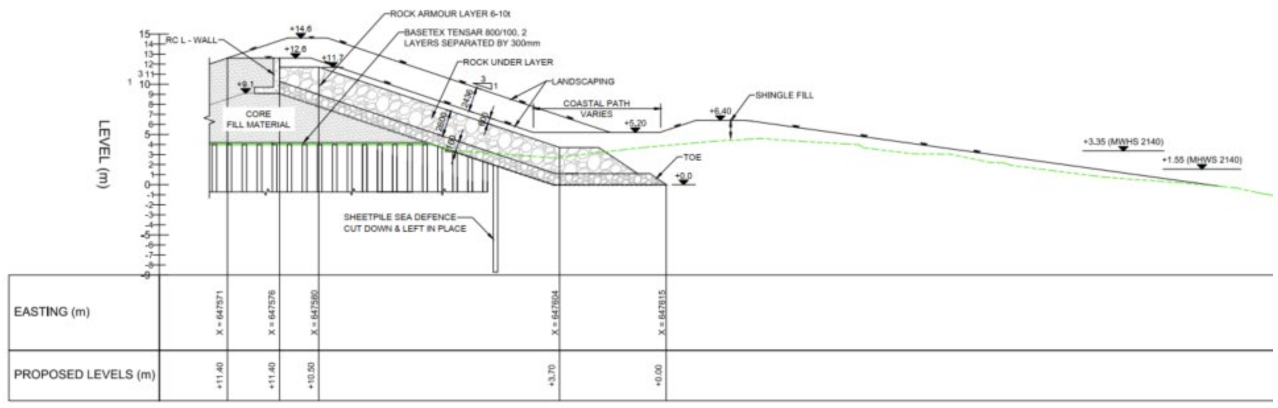
3.7.1 The proposed Soft Coastal Defence Feature (SCDF) refers to the proposed enhanced and maintained upper (shingle) beach at Sizewell. Currently, the upper beach is distinct from the mostly sandy sub-tidal beach that extends offshore and includes sand bar features.

3.7.2 The purpose of the SCDF would be to maintain the natural alongshore drift of sediments to avoid impacts on downdrift shorelines, and to prevent exposure of the HCDF. In so doing, by virtue of its physical presence, the SCDF would also afford protection from wave attack.

3.7.3 The SCDF was outlined in the May 2020 DCO application. Infilling to the beach crest was shown on the supporting drawings (refer to Figure 2-3).

3.7.4 The SCDF is defined by an upper profile that would be created from beach recharge and a lower section that the beach profile should always be above, refer to Figure 3-3 and Appendix A.3. An initial recharge of the beach during construction will create the upper profile. There will be subsequent periods of recharge during the life of the sea defences, if and when the beach erodes to the extent that triggers the need for recharge. This is described further in section a) *et seq.*).

Figure 3-7 – SCDF, Upper Maintained Profile and Initial Beach Recharge Profile



Existing beach profile (indicative) – shingle fill above this line is initial beach recharge

b) Geomorphology

3.7.5 As detailed in Volume 2, Chapter 20 (Coastal Geomorphology and Hydrodynamics) of the ES (Book 6) [APP-311], the Sizewell frontage is comparatively stable compared to neighbouring shorelines. However, expert geomorphological assessment contained in Appendix 20A of the ES concluded that, without mitigation, the shore would erode back within a few decades, risking exposure of the HCDF by 2053-2087. The proposed SCDF would be designed so that part of it would be deliberately sacrificial, releasing sediment into the local sediment system in major storm events that would reduce erosion rates of the beach along the SZC frontage, and therefore avoid potential impacts of the HCDF on neighbouring shorelines. Further details of the proposed design are provided below.

c) SCDF Design

3.7.6 The behaviour of the SCDF in design basis storm events has been numerically modelled and eroded post-storm profiles derived as explained at Section 3.4.4. The introduction of beach replenishment material (pebbles and cobbles) on the shoreface and backshore (beach crest) as proposed would ensure that a protective beach is maintained seaward of the HCDF.

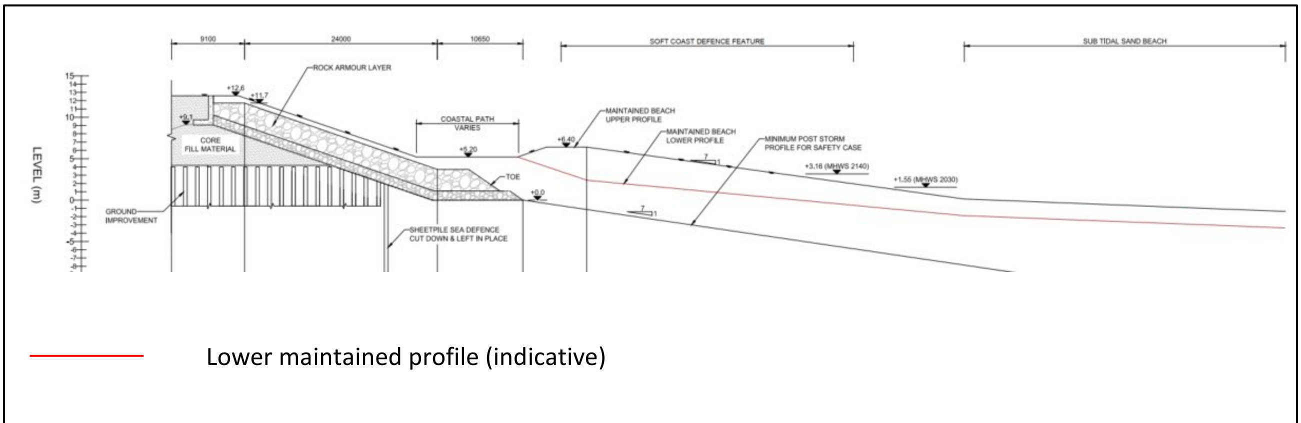
3.7.7 Figure 3-7 and Appendix A.3 show the proposed infilling required to create the SCDF, being the volume between the existing beach (green dashed line) and the proposed beach profile (upper black line). This infilling and shaping of the existing beach would be undertaken immediately following construction of the HCDF.

3.7.8 The SCDF would start at the seaward face of the HCDF, following the approximate alignment of the proposed coast path. Seaward of the coast path, the SCDF would rise to form a bund with an approximate crest level of +6.4m OD, before sloping down gently to merge with the existing beach profile. The exact shape, crest level, and crest width of the SCDF will be determined at detailed design stage

3.7.9 The infilling would use pebbles and cobbles but towards the coarser end of the size spectrum of the existing beach, in order to be naturalistic whilst also yielding enhanced longevity to reduce the frequency of subsequent recharge events. BEEMS technical report TR544[2], gives further details of the proposed beach recharge material.

3.7.10 Figure 3-8 and Appendix A.4 show the indicative proposed maintained profiles.

Figure 3-8 – SCDF, Indicative Lower Maintained Profile



3.7.11 The lower maintained beach profile shown in red on Figure 3-8 and Appendix A.4 is required to maintain the safety case for the sea defences such that the toe of the HCDF at +0.0m OD is not exposed in a design basis storm event. Again, the exact shape/volume of this profile will be determined at detailed design stage. The SCDF would be recharged to ensure that the lower maintained profile is not realised.

3.7.12 BEEMS technical report TR544[3], has proposed that beach recharge would be based on a volumetric approach. The SCDF is conceptually divided into two main components:

[2] 2021 CEFAS BEEMS Technical Report TR544 Rev 02
[3] 2021 CEFAS BEEMS Technical Report TR544 Rev 02

- landward safety buffer volume (V_{buffer}), which is not intended to be depleted or frequently exposed but is sufficiently large in itself to avoid HCDF exposure under severe storms.
- seaward sacrificial volume V_{sac}, which would be allowed to erode as far back as V_{buffer} ,before being recharged. The rationale for the safety buffer component is to protect against storms or storm sequences just prior to recharge.

3.7.13 The profiles shown on Figure 3-8 will be subject to further study and modelling work during the detailed design phase, and the lower maintained profile indicated in red on the figure would be revised accordingly.

d) SCDF and Beach Maintenance

3.7.14 When the SCDF has eroded to pre-defined levels it would be recharged ('topped up' with sediment) in order to maintain a protective beach between the HCDF and the sea. The Coastal Processes Monitoring and Mitigation Plan (CPMMP) (Appendix 2.15A, Volume 3, Chapter 2 of the ES Addendum) [AS-237]), to be approved under DCO Requirement 7A and Marine Licence Condition 17, details the methods to monitor erosion of the SCDF and will define the levels at which recharge is required.

3.7.15 These matters are currently under investigation and subject to further study. The CPMMP would be administered and periodically reviewed by the 'Marine Technical Forum' which is to be secured and funded through obligations in the Section 106 Agreement (Doc Ref. 8.17) for the development.

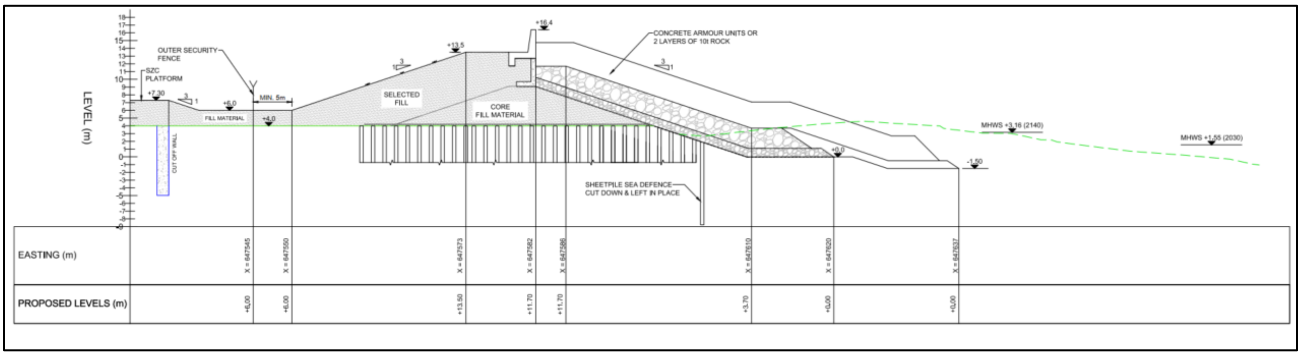
3.8 Adaptive Design

3.8.1 The HCDF is designed to protect Sizewell C from a 1 in 10,000yr storm event with "Reasonably Foreseeable" (RF) climate change effects up to the end of its design life in 2140. Further details of the RF case are given in Sections a) *et seq*. The RF sea level rise is taken from UKCP018 RCP8.5 (95%tile) and is, therefore, a conservative estimate. A value of 10% was added to design wave heights and periods.

3.8.2 Owing to the inherently uncertain nature of climate change, it is recognised that the RF climate change scenario may be exceeded, leading to more onerous climate change effects becoming prevalent. ONR and EA guidance therefore requires that the sea defence be capable of adaptation to a Credible Maximum (CM) sea level rise. The CM scenario is defined as the H++ climate change scenario as defined in UKCP09, as UKCP18 refers back to the UKCP09 estimates and does not provide updates estimates (refer to section 3.3.4a) *et seq*). The sea defences have therefore been designed to allow for future adaptation to accommodate the CM scenario, should it develop. The modified defences that would be delivered through implementing these future adaptations is termed the “Adaptive Design”.

3.8.3 Figure 3-9 shows the Adaptive Design, with tidal levels shown reflecting RF sea level rise to 2140. A larger-scale section is provided at Appendix A.5. The Adaptive Design of the HCDF would retain the SCDF in front of it.

Figure 3-9 - Adaptive Design, Typical Cross-section of HCDF



3.8.4 In the Adaptive Design, concrete armour units would be overlaid on the previously placed rock revetment, and the toe section extended further seaward to a lower level. A toe level of -1.5mOD would be required, i.e. 1.5m deeper compared to when the proposed HCDF is originally built.

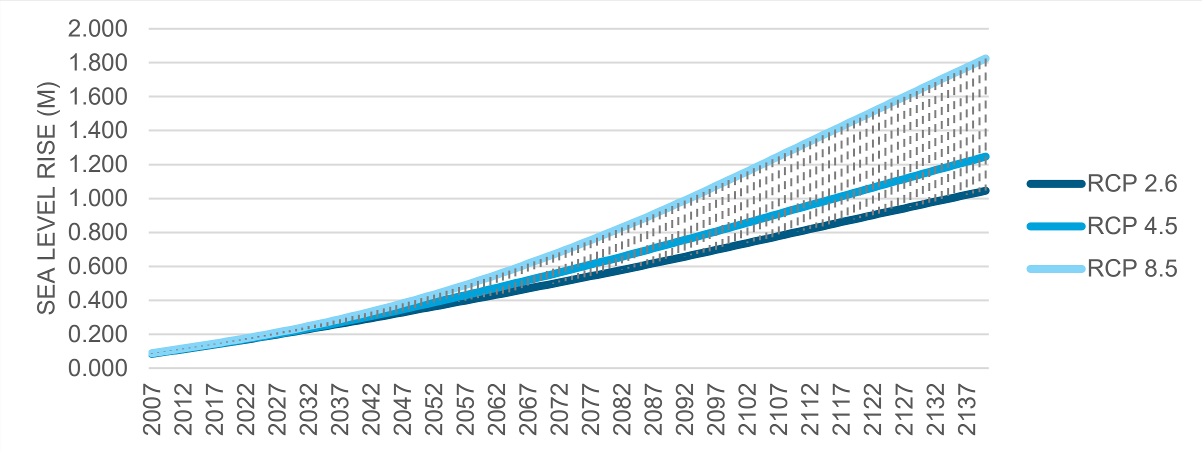
a) Trigger Levels for Adaptive Design

3.8.5 The implementation of measures to enact the Adaptive Design would be driven by progressively observed effects of climate change, specifically mean sea level rise.

3.8.6 The need to implement the Adaptive Design is only expected to occur if mean sea level is forecast to exceed the Reasonably Foreseeable design value (RCP8.5 95%ile). The current UKCP18 RCP 8.5 95%ile sea level rise estimate to 2140 is 1.825m. Figure 3-10 shows the UKCP18 sea level rise estimates. It will be obvious which trajectory is being followed decades before the design value is exceeded, allowing implementation of the Adaptive Design before the threshold is reached.

3.8.7 International and UK Government Climate Change predictions are also expected to be regularly updated and refreshed, and the UKCP18 predictions compared against future predictions.

Figure 3-10 - UKCP18 RCP's (95%-ile)



3.8.8 Paragraph 7.1.37 in the Main Development Site Flood Risk Assessment (MDS FRA) (Doc. Ref 5.2A) [AS-018] confirms that the impacts of climate change on sea level rise would be monitored and assessed at set intervals (e.g. 10 years) to determine the trajectory of the projections (e.g. in terms of sea level rise or increased storminess) and consider whether there is any change from either the currently considered projections or the climate change guidance as applied within the Application. This is in line with the Nuclear Site Licence requirements, whereby an appropriate monitoring programme needs to be in place and that a periodic safety review is undertaken.

3.9 Minimising eastward extent

3.9.1 Opportunities to reduce the eastward extent of the Permanent Sea Defence fall into two general groups:

- Move the HDCF further inland.
- Reduce the overall width of the HCDF.

3.9.2 The form and location of Temporary HCDF does not drive the seaward extent of the Permanent HCDF. The adoption of the Temporary Sea Defence has allowed the construction phase plot plan to be optimised, minimising the occupation of the beach and foreshore during this phase.

a) Move HCDF further inland

3.9.3 The HCDF construction is constrained by the minimum 5m standoff from the outer security fence to the landward toe of the sea defence in the Adaptive Design configuration, refer to Section 3.6, Figure 3-9 and Appendix A.5.

3.9.4 The landward toe of the HCDF cannot therefore be moved further west unless the outer perimeter fence also moves to the west. Moving the perimeter fence to the west could only be achieved through either compressing the East-West extents of the SZC platform, or by moving the entire platform further west.

3.9.5 The SZC platform configuration, including offsets between perimeter fencing and internal assets, and between internal assets on the platform, has been optimised to minimise space requirements and to maximise replication with the HPC layout. Further East-West compression of the platform layout is therefore not considered feasible. It is also not considered feasible to relocate the entire SZC platform further west as this would further increase land take from Sizewell Marshes Site of Special Scientific Interest (SSSI) which would not be appropriate.

3.9.6 It is therefore not considered plausible to modify the operational SZC platform position or configuration, nor the position of the outer security fence relative to the internal platform area to lessen the seaward extent of the sea defences.

b) Reduce width of HCDF

3.9.7 Two key opportunities to reduce the overall width of the Permanent Sea Defence were considered, as follows:

- Steepening of slopes
- Reduction of crest level

3.9.8 A reduction in the eastern extent of the Permanent Sea Defence could be achieved by adopting a lower crest height, however as the crest height is the key functional parameter of the sea defences in limiting overtopping, this has not therefore been considered further.

3.9.9 Increasing gradients to minimise the eastward extent was considered, but was discounted for the following reasons:

- A steeper seaward slope would require a higher crest level to achieve the same overtopping performance.
- A steeper seaward slope would require larger rock armour or the use of concrete armour units.
- A slope steeper than 1 in 3 would be difficult to establish grass on and difficult to maintain as motorised machinery could not be used. This applies to both seaward and landward slopes.

- A slope steeper than 1 in 3 would require reinforcement to be stable for seismic loading. This applies both to seaward and landward slopes.
- A landward slope steeper than 1 in 3 would be less resistant to surface erosion from overtopping water.

3.9.10 Neither of these two options were considered acceptable.

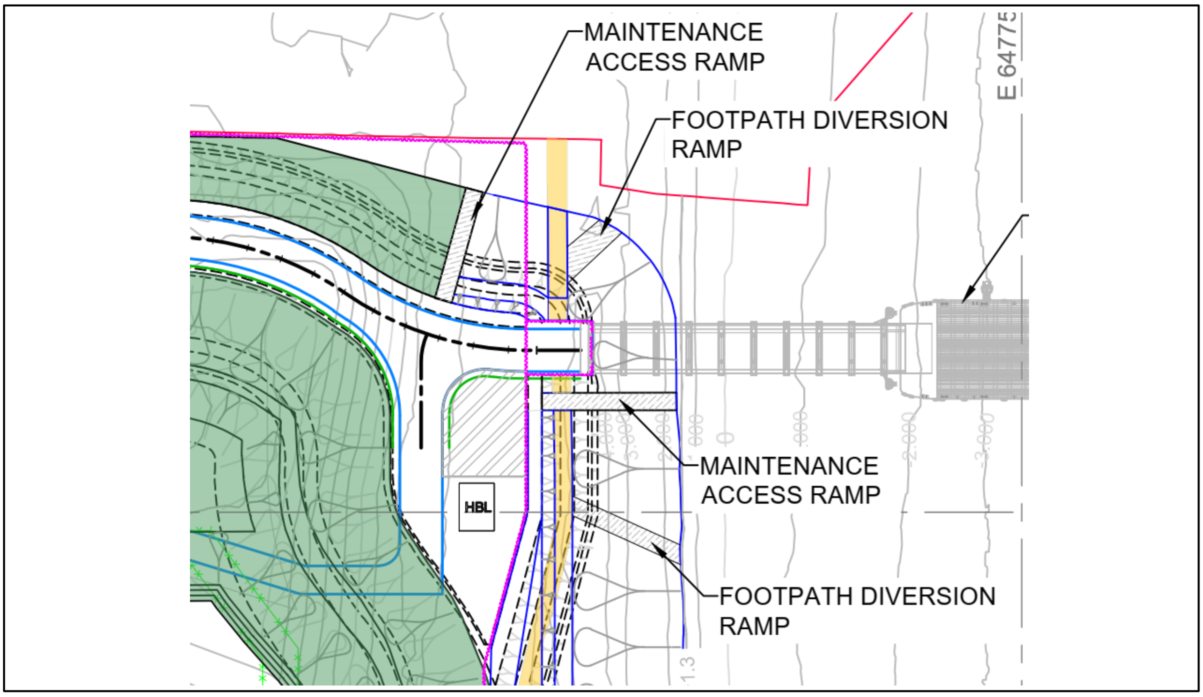
c) Alignment at BLF

3.9.11 At the Permanent BLF the seaward line of the sea defences has not changed from the first DCO submission.

3.9.12 However, the updated design drawings show additional features, refer to Figure 3-11. These include:

- Maintenance access ramps: required to maintain the soft sea defence and repair the hard sea defence. These will be permanent structures.
- Coast Path diversion ramps for when the Permanent BLF is in use. These are intended to be a soft feature created using shingle/sand beach material and temporary in nature.
- A sheetpile abutment wall that replaces the end span on the Permanent BLF. This allows the Coast Path to cross the Permanent BLF at grade.

Figure 3-11 – Permanent BLF Interface



3.10 Design Summary

3.10.1 Table 3-4 summarises the principal dimensions and levels of the May 2020 and January 2021 Submissions. Design details are for the proposed permanent HCDF, prior to the potential implementation of the Adaptive Design.

3.10.2 Figure 3-12 (larger version at Appendix A.1) shows a comparison of the two designs.

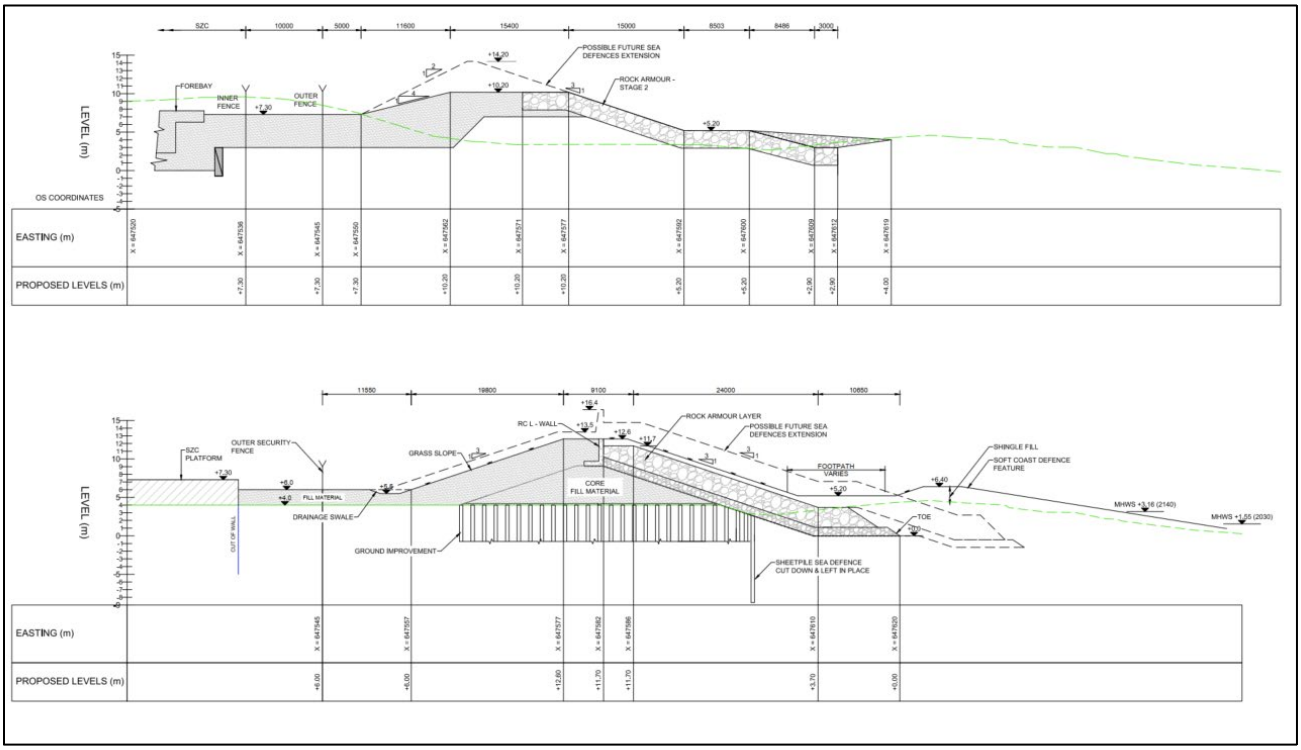
3.10.3 Additional and/or updated details shown on the design drawings, include:

- SZB/SZC interface.
- Ground improvement, to strengthen the existing soil and support the HCDF.
- Drainage swale, to capture, convey and attenuate surface water runoff originated from both overtopping and rainfall events; and
- Landscaping, to provide at least 600mm of coverage over the seaward face of the sea defence, to crest levels varying between 13.2 m OD and 14.6m OD.

Table 3-4 - Summary of Changes to HCDF

Element	May 2020 DCO Submission	January 2021Change Submission
Crest height	10.2m OD	12.6m OD
Toe level	3.0m OD	0.0m OD
Seaward toe of Sea Defence (Easting in OSGB)	647612m	647620m
Landward slope	1:4	1:3
Seaward Slope	1:3 with berm	1:3 no berm
Rock Size	Not stated	6 to 10 tonnes rock
Land level between COW and HCDF	7.3m OD	6.0m OD (variable)

Figure 3-12 - May 2020 Submission (upper) and January 2021 Change Submission (lower)



4 CONSTRUCTION AND SEQUENCING

4.1 Temporary Sea Defence

4.1.1 Construction of the Temporary Sea Defence may commence as soon as a suitable access is made available to the works area. Plant and materials may initially be delivered to the SZC site via the SZB access to the south, transitioning to access from the north across the temporary SSSI crossing bridge. Access to the foreshore from the MCA area is likely to be created via a limited excavation at the western toe of the Northern Mound and work around to the east.

4.1.2 Installation of sheetpiles would be carried out on a number of work fronts, the number of work fronts and installation rigs being selected to support the overall construction programme. Installation would be by methods selected to minimise noise and ground-borne vibration, and may require pre-augering in some areas.

4.1.3 The southern tie-in to the SZB sea defences would be achieved by installing sheetpiles up to the designed extent, and then infilling the wedge between vertical SZC sheetpiles and inclined face of SZB embankment using shingle fill.

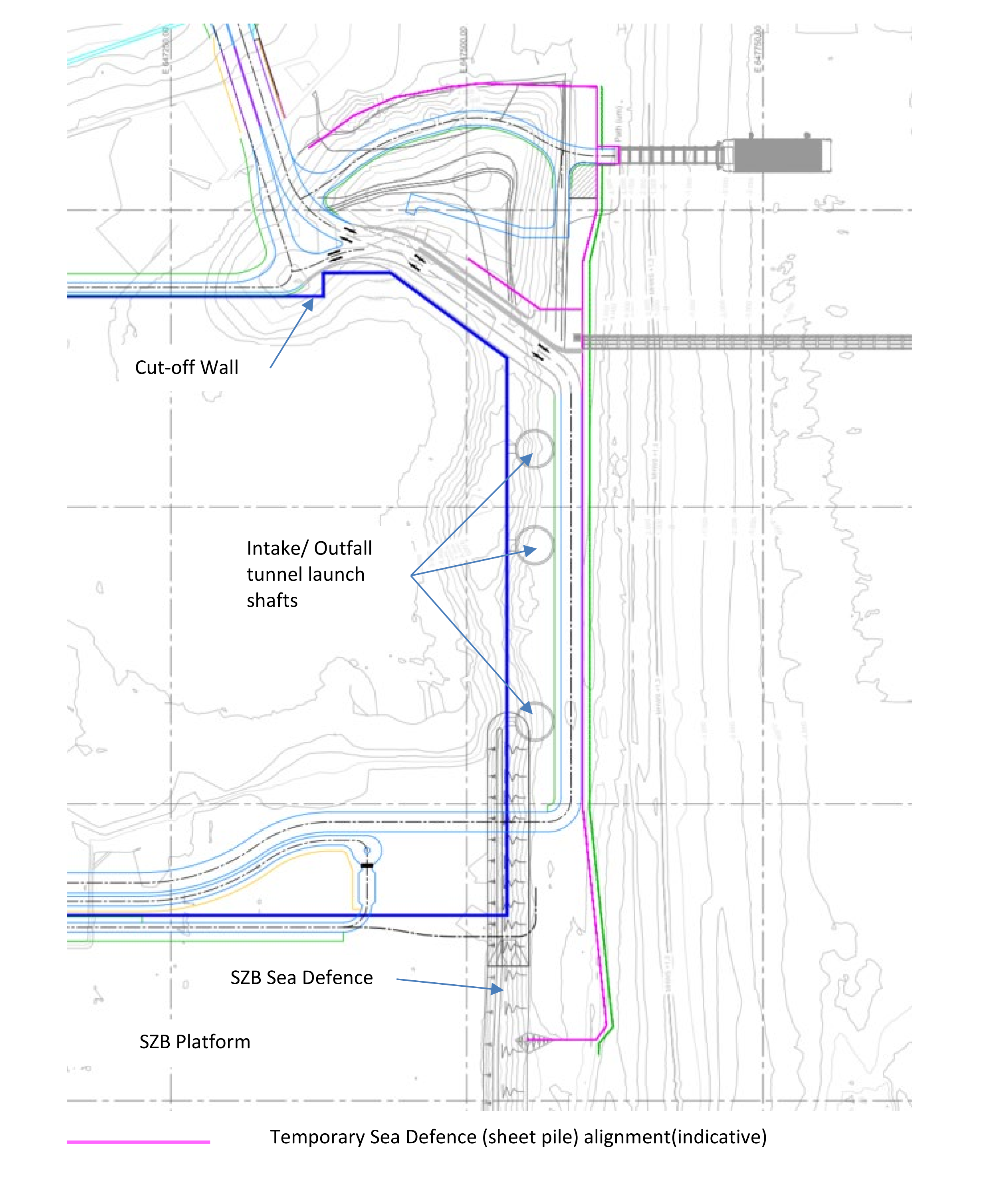
4.1.4 The northern tie in would be made into the completed SSSI crossing embankment at level +7.3mOD to protect the MCA excavation during excavation and reconstruction of the Northern Mound area.

4.1.5 Ground Improvement will be required for the Permanent Sea Defence, which would be installed at the early stage in advance of the Temporary Sea Defence, along with other similar Ground Improvement measures concentrated at the northern end of the MCA site.

4.1.6 Excavation of the MCA will commence (assuming CoW and other critical predecessors are completed) and also installation of CMCs within the sheet piled perimeter.

4.1.7 The plan view showing the temporary sheetpile sea defence in pink is shown in Figure 4-1. A typical cross-section is shown in Figure 3-2 and at Appendix A.2.

Figure 4-1 - Temporary Sea Defence (Sheet pile) plan



4.2 Permanent Sea Defence (HCDF)

4.2.1 The Permanent Sea Defence will be constructed towards the end of the construction phase, once bulk excavation, filling and main construction activities for SZC are complete.

a) Southern Tie-in

4.2.2 The SZC Permanent Sea Defence, including the southern termination, would be constructed without interacting with the existing SZB Sea Defences. The wedge between the structurally independent SZB and SZC Sea Defence systems would be infilled with shingle or other material prior to landscaping.

b) Main (Central) Section

4.2.3 Once the tunnel works are complete and the construction haul road is no longer required the south run of the reinforced sea defence core can be installed.

4.2.4 Construction of the Permanent Sea Defence would be carried out in stages. As the Permanent Sea Defence is constructed, the Temporary Sea Defences would be removed or cut down to permit the construction of Permanent Sea Defence.

4.2.5 For each section of embankment, excavation would be carried out for the toe of the proposed embankment: the dig is on both the west and the east side of the sheet pile.

4.2.6 It has been assumed that the operation to excavate and place the different layers comprising the embankment will be carried out in short manageable sections to prevent undue exposure of the unprotected core.

c) Northern Mound

4.2.7 Within the Northern Mound area, the core of the Permanent Sea Defence would be raised to approximately +8mOD level, and new Permanent BLF access road constructed (levels vary +5m to +7.3m).

4.2.8 The surface of the new defence core must be protected against erosion and weathering using a concrete canvas or similar durable barrier.

4.2.9 With the erosion protection in place, the Northern Mound will provide effective protection to the MCA excavation. The sheet pile wall would be breached to allow access to construct the land-side piles for the Permanent

BLF. At this stage, the sheet pile wall would still be the primary defence against attack/ degradation by wave energy in severe storm conditions.

4.2.10 Once the Permanent BLF is complete and operational, the remaining under-rock and rock armour would be imported to complete the Permanent Sea Defence to design levels in the northern mound area.

4.2.11 Once the rock armour is in place from the SSSI to the re-entrant corner on the east of the MCA, the sheet piles in the Northern Mound corner can be removed as the permanent defences would be functional.

d) Permanent Sea Defence (SCDF)

4.2.12 Following construction of HCDF, the SCDF profile would be formed using dredged imported shingle material and any suitable site won material. A trailer suction hopper dredger would dredge material from a licenced offshore site, and then moor off SZC. The shingle would then be pumped ashore using a pipeline and moved into the profile using bulldozers.

4.2.13 Any future recharge of the beach during the design life of the sea defences would use a similar methodology as the initial creation.

4.3 Adaptive Design

4.3.1 The Adaptive Design has been developed to provide a simple means of increasing the crest height of the Permanent Sea Defence if required to respond to observed climate change effects exceeding the design basis. Construction of the Adaptive Design would involve placing additional armour, a wave wall and landscaping on the top of the Permanent Sea Defence, reaching a crest level of 16.4m OD.

4.3.2 The core and associated foundations required to support the Adaptive Design would be installed as part of the initial Permanent Sea Defence construction and would not require further intrusive work at a later stage.

4.3.3 The Adaptive Design would be implemented by placing an overlay of rock armour or concrete units over the originally placed revetment. The embankment and toe would be extended outwards and downwards as part of the Adaptive Design implementation. These Works would include excavation within the beach/ SCDF to permit the extension and lowering of the HCDF toe, and the transport and placing of armourstone units to form the new revetment. Placement of the toe armour would be within the tidal zone.

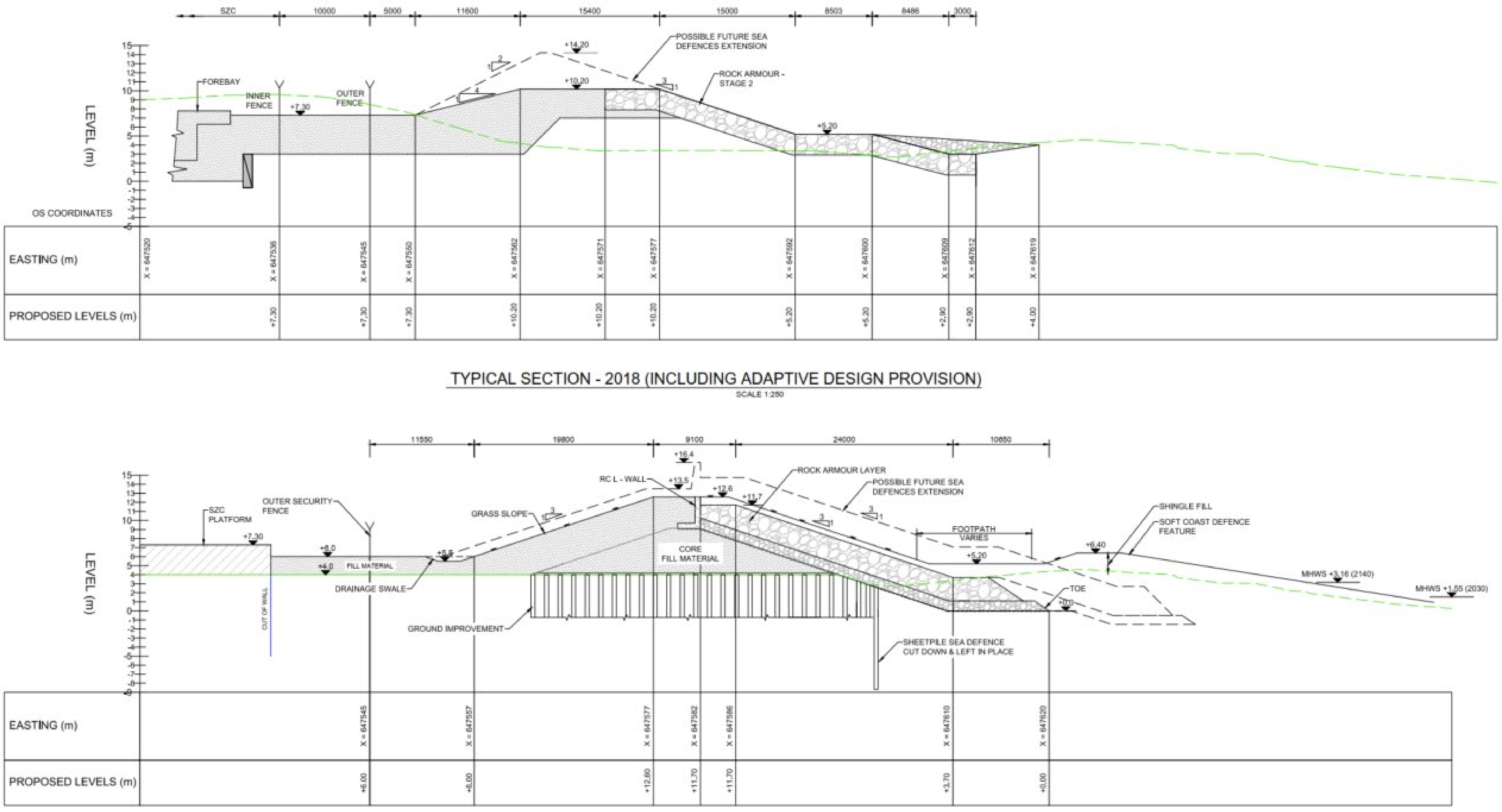
4.3.4 Additional armour may be imported via the Permanent BLF, which would be retained throughout the life of SZC. Additional fill material could also be imported via the Permanent BLF or by road and hauled along the foreshore.

4.3.5 The precise construction methods, timing and sequencing by which this would be implemented will depend on the SZC and SZB configuration at the time. The design has been developed to be simple to implement, and does not require unusual or unique plant, materials, methods or access arrangements.

APPENDIX A: TYPICAL CROSS SECTIONS

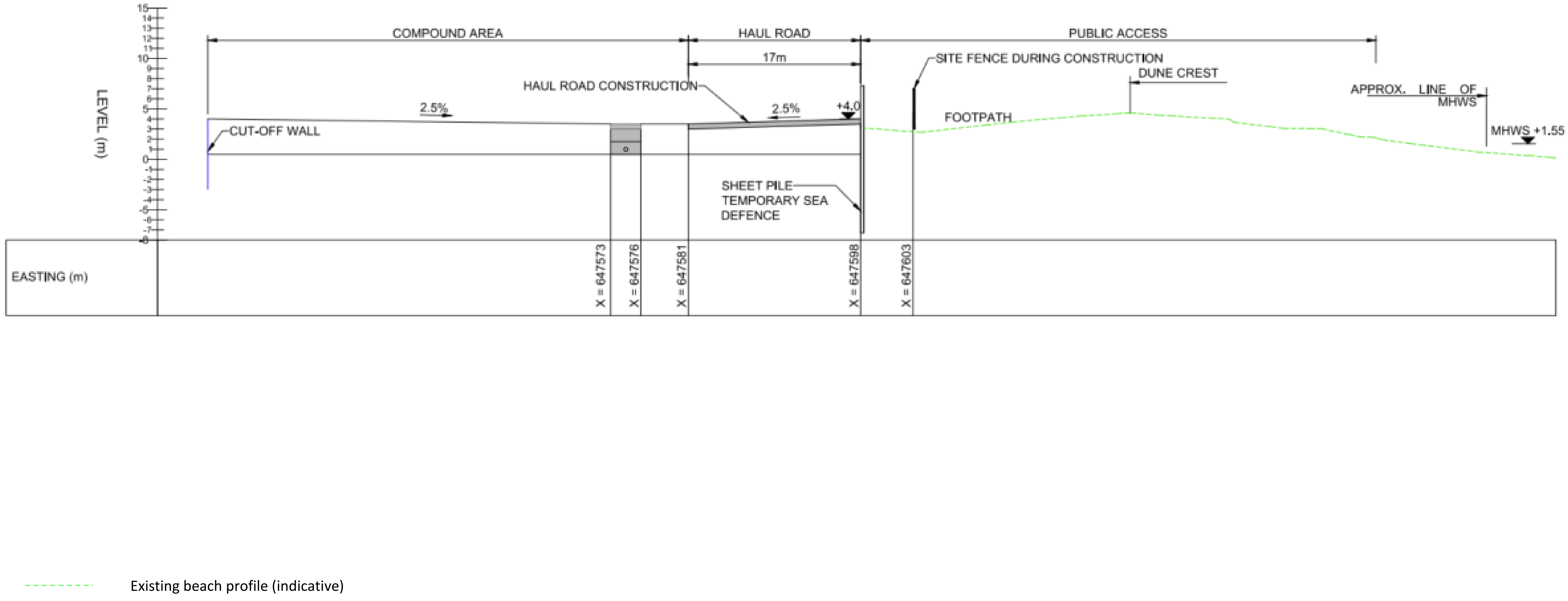
This Appendix contains larger-scale versions of selected figures presented elsewhere in the report, to provide improved legibility of details.

A.1. May 2020 Submission (upper) and January 2021 Change Submission (lower) - Figure 3-12

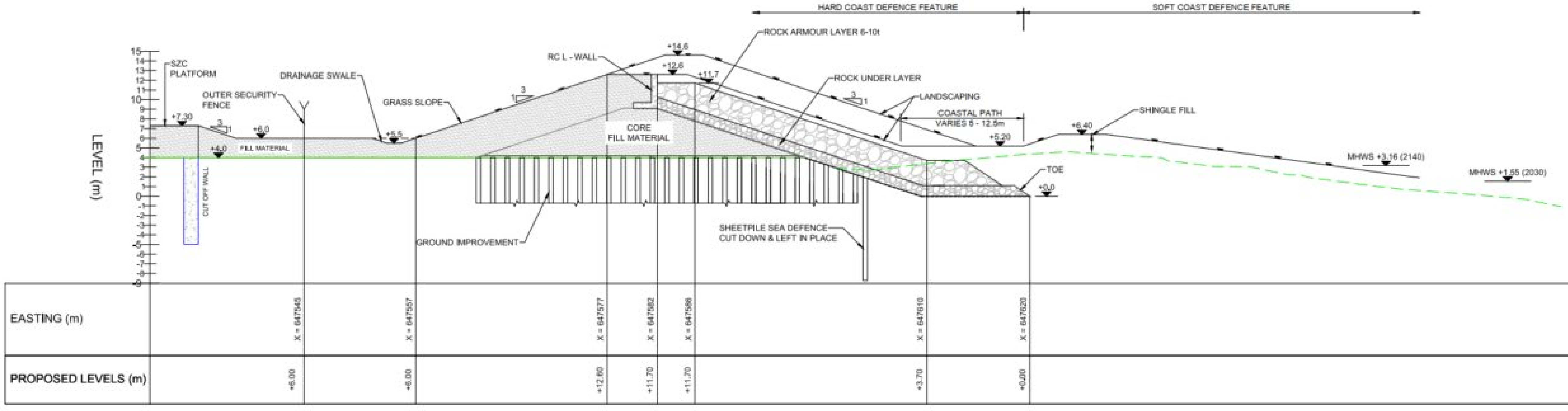


Existing beach profile (indicative)

A.2. Temporary HCDF, Typical Cross-section Underpinning January 2021 Submission (Figure 3-2)

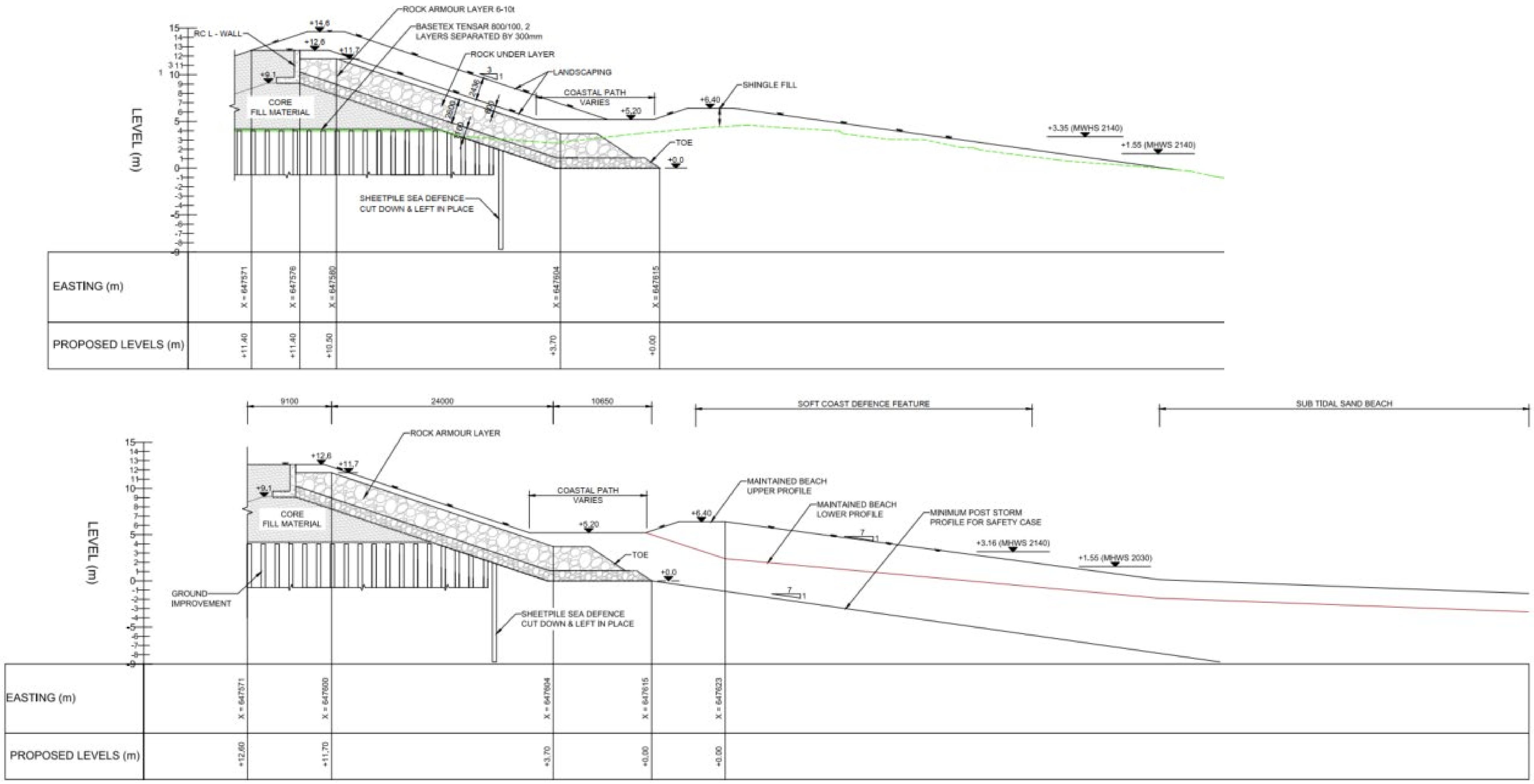


A.3. Permanent Sea Defence, Typical Cross-section (Figure 3-3)



Existing beach profile (indicative)

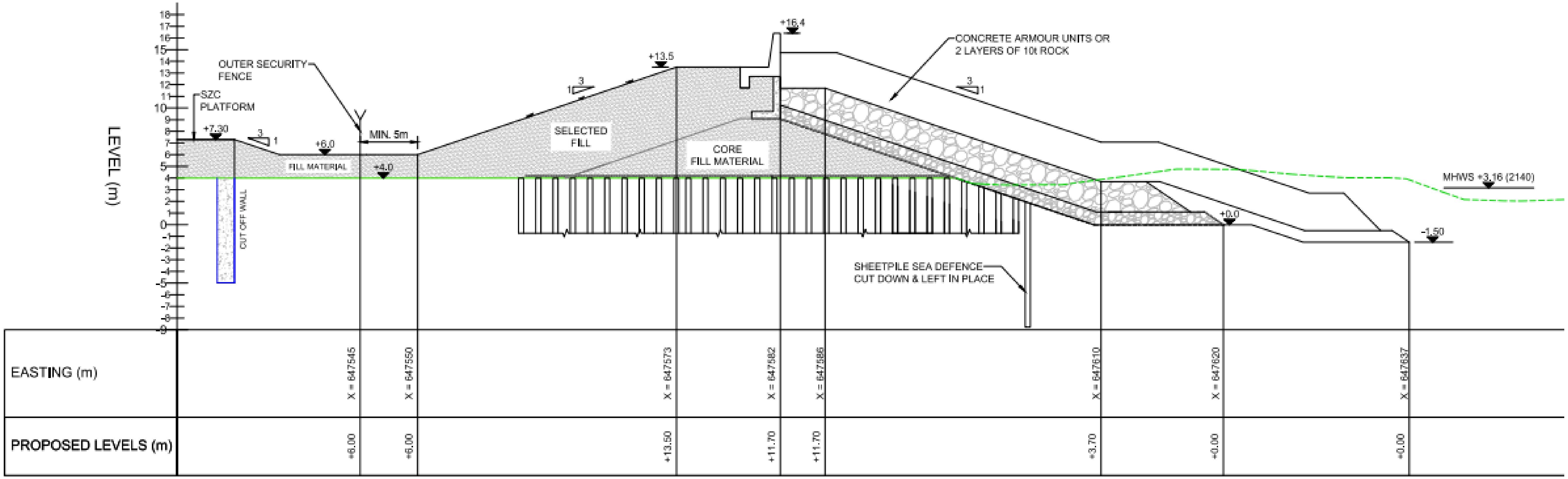
A.4. SCDF, Upper Maintained Profile and Initial Beach Recharge Profile (Figure 3-7), Indicative Lower Maintained Profile (Figure 3-8)



Existing beach profile (indicative) – shingle fill above this line is initial beach recharge

Minimum Maintained Profile (indicative) – shingle fill above this line is maintenance recharge

A.5. Adaptive Design - Typical Cross-section of HCDF (Figure 3-9)



- - - - - - Existing beach profile (indicative)

Page Intentionally Blank